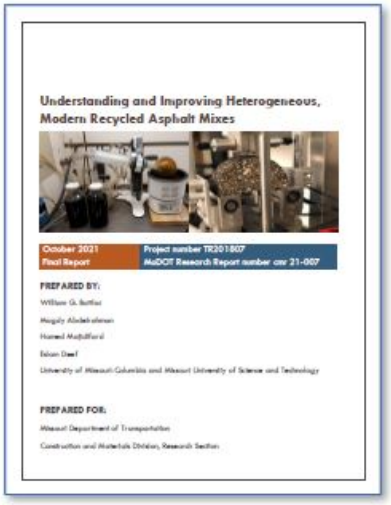
For more information contact: Jennifer Harper (573) 526-3636

Research Summary

Understanding and Improving Heterogeneous, Modern Recycled Asphalt Mixes



A comprehensive research investigation was carried out to investigate the use of recycled materials in Superpave asphalt mixtures in Missouri. The investigation involved sampling of aggregates, binders, plant-produced mixtures, and field cores followed by a rigorous lab testing program. Lab testing included an extensive binder extraction and recovery (E & R) experiments, followed by a comprehensive suite of advanced binder tests.

An attempt was made to shed light on effective strategies to iterate existing mix designs into more 'balanced mix designs' for modern, heterogeneous recycled mixtures in the Midwest. Different strategies were employed, such as the use of a softer virgin binder, the addition of a rejuvenator, and the employment of 5% to 20% of dry-process, engineered crumb rubber by weight of total binder. These mixes were subjected to a suite of cracking and rutting mixture performance tests to establish baseline performance, followed by four additional mix design iterations per mix (for a total of 10 investigated mixtures). The DC(T), I-FIT, IDEAL-CT, and Hamburg wheel tracking tests were used in the performance testing suite.

Evaluating BMD optimization as a whole, the use of a softer binder was the most effective strategy to optimize SCB(I-FIT) and IDEAL CT cracking test scores, while the incorporation of rubber along with a softer base binder and supplemental binder was the most effective method to maximize DC(T) fracture energy test results. In all cases, modern recycled mixtures appear to have a significant factor of safety against rutting, which suggests the increasing importance of softer virgin binder grades and effective rejuvenators and the importance of accessing these materials without greatly increasing asphalt mixture costs.

> *" The movement towards increased sustainability in asphalt mixtures will require continued balancing of increased recycled material usage, mixture durability, and mixture economics."*

Based on the findings and conclusions of this study, it is recommended to use the centrifuge MMDM for binder E & R if the filterless centrifuge device is available. The practice of recommending or requiring a softer virgin binder grade when recycled materials are used should be continued, even as BMD is rolled out. A simple table was developed to assist mix designers in this regard. When designing with very stiff recyclates, such as highly weathered RAP sources, RAS or waste plastic, it may be necessary to apply a weight factor to the stiffer

recyclates. Current MoDOT specifications recommend that for mixes containing both RAP and RAS, the ABR should be computed as the ABR by RAP plus two times the ABR by RAS. A similar weight factor may be necessary as waste plastic mixtures are introduced. Recommendations for rejuvenator and GTR use were also provided.

When designing at higher ABR levels and/or when using stiff recyclates, additional strategies may be required beyond virgin binder grade softening and rejuvenator use.

The movement towards increased sustainability in asphalt mixtures will require continued balancing of increased recycled material usage, mixture durability, and mixture economics. Major sacrifices in one or more of these three categories will not truly lead to long-term, sustainable solutions. Finally, this study highlights the significant challenges confronting the industry with respect to the need for even softer base binder supplies and a broad slate of effective rejuvenators, tailored to binders and aggregates with differing chemical characteristics.

Figure 1: Fabrication process

Project Information

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CONTACT INFORMATION:

Jennifer Harper
Research Director
Missouri Dept. of Transportation
1617 Missouri Blvd.
Jefferson City, MO 65109
(573) 526-3636
Jennifer.Harper@modot.mo.gov